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ORIGINAL ARTICLE

# No difference in learning retention in manikin-based simulation based on role

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**Objective:** We evaluated learning retention in interns exposed to simulation. It was hypothesized that learning would degrade after 6 months and there would be a difference in retention between interns who played a critical role versus those who did not.
**Methods:** A total of 23 groups of 5 to 9 interns underwent a cardiac scenario twice during 1 simulation experience and again 6 months later. We captured 69 recordings (23 before debrief at baseline [PrDV], 23 after debrief at baseline [PoDV], and 23 at 6-month follow-up [FUV]). Students were assigned different roles, including the critical role of "doctor" in a blinded, haphazard fashion. At 6-month follow-up, 12 interns who played the role of doctor initially were assigned that role again, while 11 interns who played noncritical roles initially were newly assigned to doctor. All videos of intern performance were scored independently and in a blinded fashion, by 3 judges using a 15-item check list.
**Results:** Repeated-measures analysis of variance for interns completing all 3 time points indicated a significant difference between time points ($F_{2,22} = 112$, $p = .00$). Contrasts showed a statistically significant difference between PrDV and PoDV ($p = .00$), and PrDV and FUV ($p = .00$), but no difference between PoDV and FUV ($p = .98$). This was consistent with results including all data points. Checklist scores were more than double for PoDV recordings (16) and FUV (15), compared to PrDV recordings (6.6). Follow-up scores comparing old to new doctors showed no statistically significant difference (15.4 vs 15.2 respectively, $t_{21} = 0.26$, $p = .80$, $d = .11$).
**Conclusions:** Learning retention was maintained regardless of role.

J Chiropr Educ 2016;30(1):20–24 DOI 10.7899/JCE-15-1

## INTRODUCTION

In 2009, The Lucian Leape Institute suggested that using simulation and managing medical education reform could improve patient safety.[1] Researchers agree that patient safety and preventable medical errors are an international issue.[2–9] However, for health care education to improve patient safety and provide high quality management, learning retention is critical.[10] We were interested in assessing learning retention during simulation in health care education.

Research supports the use of simulation to facilitate student learning, leadership, communication, and teamwork in an effort to reduce iatrogenic error.[1] The systematic review of Harder[7] showed that self-reported confidence and competence scores increase when participants learn in simulation environments. The systematic review and meta-analysis of Cook et al[11] pooling the data from 35,226 participants indicated significant effects of simulation associated with knowledge, skills, and behaviors. Simulation has been effective in the development of some motor skills (eg, certain surgical procedures, pilot simulated training exercises, and manipulation skills).[10,12] However, data regarding actual learning retention and its objective measurement in a simulated environment remains limited.[7,13,14] In fact, of the 240,300 articles on simulation in the US National Library of Medicine, only 0.1% could be retrieved using the key words "simulation and learning retention."

According to Friedlander et al.,[15] many key aspects of an effective learning paradigm, such as repetition, active engagement, stress, active involvement, and reinforcement, already have been incorporated into the simulation learning environment. Research indicates simulation to be realistic and effective.[16] Questions still exist, however, regarding how much learning is occurring and how generalizable this is, dependent on the role played by a student, in a simulated environment. As student involvement may vary by role played (eg, office receptionist [more observational] versus clinician [more active]) in a clinical scenario, theories associated with the generation effect and with PBL (problem based learning)[17] suggest that greater learning occurs for those with more active participation.[18]

Appropriate evaluation of student learning is key to understanding retention and the implications of involvement. Rating clinical student performance always has been challenged on the basis of subjectivity.[19] Challenges to clinician evaluation of student performance can be mitigated through the use of recorded clinical activities whereby disputes are reassessed and discussions around the successful completion of learning outcomes are promoted.

Despite the use of recordings, subjectivity relative to scoring student outcomes remains. To minimize bias, a panel of judges can be used to document learned behaviors. Methods of judge selection are based in theories associated with judge accuracy and probability of correct decision-making in situations where evaluations are unblended.[20] Because the accuracy of judgments can be significantly and adversely affected by social influences creating pressure for conformity, theories of accuracy and probability of correct decision-making should be combined with theories associated with the "wisdom of crowds" effect.[21] As such, in this investigation, methods were used whereby panel members remained independent and blinded to each other's evaluations.

The specific aim of this investigation was to determine learning retention in interns exposed to a simulated cardiac event using a panel of judge's criterion rating system for assessment. It was hypothesized that without additional intervention, there would be degradation in learning between an initial simulation learning exercise and a simulation exercise provided 6 months later. It was hypothesized further that there would be a difference in learning retention at the 6 month follow-up between interns who played a critical role in the initial lab and those who did not.

## METHODS

### *Study Parameters*

This study made secondary use of prerecorded video data collected from the 2011 academic year, including all interns enrolled in their final year of study ($n = 185$). All students participated in an initial high fidelity, manikin-based simulated cardiac event. The study methods were approved by the research ethics board at the Canadian Memorial Chiropractic College (REB 1401X01). Students entering their internship year were provided with simulation experiences within the first 2 months of their first rotation. All students had previously successfully completed an academic course in emergency care.

Interns were grouped into "pods" of 5 to 9 participants (23 pods total), by the institution's clinic management team based on student preference, clinic location, and clinician availability. Interns were accompanied by their supervising clinician for a simulation experience during the pod's normally scheduled 2-hour administrative time.

The simulation lab was set up to look like a private health provider's office. Interns chose their identity (doctor, family member, receptionist, waiting room patient, patient in next room, and so forth) by selecting a clip board with a concealed role on it. No a priori information was provided regarding the case that would be used, or the role that they would play, before entering the simulation environment. Upon completion of role selection, the coordinator briefed each student individually regarding the intent of their role. This included, for example, explaining to the student that their persona should be persistent in asking questions from a layperson's perspective, or that they were to become very emotional as the scenario unfolded. There was no collaboration between students before the recording of the experience.

Once briefed on their roles, the event was played out, recorded, and labeled as a "predebriefing video" (PrDV). Interns then were provided with a full debriefing of all key teaching and learning outcomes relevant to the clinical scenario. Included was the presentation of a reference video to reinforce learning points. Interns then were required to repeat the original simulated event, while retaining their original roles. This also was recorded ("postdebriefing video" [PoDV]).

To address the proposed hypotheses, a follow-up simulation session was arranged 6 months later. During the 6 months before the follow-up no students had been involved in a clinical cardiac emergency event as a result of their internship. At the time of the follow-up, intern rotations had changed and a set of 23 newly reorganized pods were formed from the same intern base. Six of the new pods did not have interns who had fulfilled the doctor role in the previous simulations. These six pods, therefore, were assigned new "doctors," for the follow-up simulation, using a random number generator. Of the newly assigned clinic pods, 11 had 1 intern in each group who had played the role of doctor in the previous simulations. For this set of pods, a random numbers generator was used to allocate 5 of these groups to have a new doctor assigned for the follow-up simulation. For the remaining 6 pods, the intern playing the role of doctor in the previous simulations was retained in the role of doctor for the follow-up. Finally, there were 6 newly formed pod groups where multiple interns had played the role of doctor in the previous simulations. For these pods, a random number generator was used to allocate which of the interns playing the doctor role previously would retain that role during the follow-up. This reorganization and allocation method resulted in a total of 11 interns being newly designated in the role of doctor for the follow-up simulation, and 12 interns retaining this critical role.

Upon completion of this doctor selection process, each pod was brought into the lab for a follow-up simulation session, 6 months after their initial experience. No information was provided regarding the reason for coming into the lab. Once the interns entered the lab they were informed that they would be running through the same scenario that they had participated in previously. Interns who had not been allocated to the doctor role chose their new assignment by selecting an overturned clip board, as per their initial simulation experience. After clip board assignment, each group member was again instructed regarding their role. Interns were asked to review in their mind their initial simulation experience.

The follow-up simulation session (FUV) then was recorded and thereafter, each pod of students debriefed about the objectives of the session and their performance. Students were encouraged to reflect on the feedback they were given and to try and practice these skills to improve future patient management.

Upon completion of the follow up session, a total of 69 video recordings of simulated cardiac events was available for evaluation (23 PrDV, 23 PoDV, and 23 FUV). Each recording was approximately 3 to 7 minutes long.

Using methods previously validated on a subsample of 9 videos, each of the 69 recordings were viewed in a random (computer generated) sequence and scored independently by a panel of 3 judges.[13] To briefly review the methods, 3 judges were chosen on the basis of having clinical experience and expertise associated with manikin-based simulation events. Before viewing the videos judges were offered a complete explanation of the protocol to be followed. They were informed that they would be viewing videos of interns participating in a mandatory simulation event. They were reminded about confidentiality and its relevance to this study. Judges viewed the videos simultaneously, but were hidden from each other by room dividers, so as to insure complete independence in their evaluations. Judges were told about the scenario and instructed to assess the performance of the interns playing the doctor role, by circling yes or no on a checklist of 15 items related to learning outcomes anticipated from the experience. In addition, judges were asked to rate overall performance based on 4 options (very good, satisfactory, borderline or poor) where a score of 0 was given for a rating of poor and a score of 3 was given for a rating of very good. This resulted in a possible total score of 18. Previous evaluation of the checklist tool used in this investigation, and the methods used indicated strong interjudge reliability (ICC=0.74-0.92,).[13]

### *Analysis*

Outcomes for the study were based on a continuous scale of the average scores of the judges for the checklist, for each grouping of 23 PrDV, 23 PoDV, and 23 FUV. These 3 groupings are referred to, in the Results, as retention points whereby interns have had increasing levels of exposure and potential for retaining learning outcomes. Statistical analysis was completed using Stata/SE 8.2 (College Station, TX, USA). A repeated measures analysis of variance (ANOVA) was used to evaluate for differences across time points among the interns who played the role of doctor at all assessment periods (12 interns retaining this critical role). To also consider interns who had initially played a minor role and the role of the clinician later (11 interns newly designated to the role of doctor), a 1-way ANOVA also was used to evaluate differences in scores at the 3 retention points (PrDV vs PoDV vs FUV). Scheffe Test was used to evaluate post hoc differences between time points. Unpaired $t$-test was used to consider differences at the 6-month follow-up between interns originally assigned the role of "doctor" and those who had played a lesser role.

## RESULTS

Because the evaluated activities were curriculum requirements, compliance with the study interventions and assessments was 100%.

Although mean judge scores were used to evaluate student learning and retention, an intraclass correlation coefficient (ICC) was completed to determine the reliability of this set of judges in comparison with the previous evaluation of the checklist.[13] The ICC in this study was 0.86.

Demographic statistics indicated that the 53% of this cohort of student interns were female and 47% were male. The age ranged from 26 to 37, with an average age of 28 years. Table 1 provides the descriptive data for the interns, grouped according to the time of the recorded experience (Retention Point). At PrDV anticipated retention is based on having completed coursework related to emergency care. At PoDV, the anticipated retention is based on having completed an initial high-fidelity manikin-based scenario involving a cardiac event, along with a full debrief and completing a second scenario directly thereafter. At FUV, anticipated retention is based on having completed the second scenario (in the critical role of "doctor" or not) and having completed the 6-month follow-up, where the clinical experience of the previous 6 months did not include an emergency cardiac event.

Evaluation of the outcome scores determined that the data were distributed normally. Repeated measures ANOVA for subjects completing all time points indicated a statistically significant difference ($F_{2,22} = 112$, $p = .00$) due to time. Posttest contrasts showed a statistically significant difference between PrDV and PoDV ($p = .00$), and PrDV and FUV ($p = .00$), but no difference between PoDV and FUV ($p = .98$). A 1-way ANOVA on the main effect of learning retention point including all subjects indicated a significant difference between the grouped video scores ($F_{2,66} = 147$, $p = .00$), with Scheffe test showing a statistically significant difference between PrDV and PoDV ($p = .00$), and PrDV and FUV ($p = .00$), but no difference between PoDV and FUV ($p = .46$).

Table 2 provides the mean scores of performance outcomes for the 6-month follow-up retention point, distinguishing between interns who played the critical role of "doctor" in the initial simulation, versus interns who played a lesser role originally (e.g., receptionist or a secondary patient), and who were allocated to the doctor role at the 6-month follow-up.

No statistically significant difference was determined in performance outcome regardless of whether the intern was grouped as having played a critical role or a secondary role in the original simulation ($t_{21} = 0.26$, $p = .80$, $d = 0.11$).

## DISCUSSION

Health care students must gain hands-on practical experience on real patients. However, this may conflict with the patient safety and the appropriate care that educational institutions and health care facilities are obligated to provide.[12] The aim of simulation use in education is to improve student learning retention and, thus, decrease medical errors. This aim has led to an increase in its use. However, the gains from using simulation are only useful if the learning is truly retained. To date, little research has been completed regarding this key issue.[7,12,22–25]

**Table 1 - Mean Scores Associated With Different Learning Retention Points**

| Retention Point | *n*, pods | Mean (SD) |
|---|---|---|
| PrDV | 23 | 6.6 (2.9) |
| PoDV | 23 | 16.0 (1.4) |
| FUV | 23 | 15.3 (1.6) |

*Note: PrDV refers to the video completed at the initial simulation exercise, before debriefing interns on their performance, PoDV refers to the videos completed at the initial simulation exercise, but after debriefing, and FUV refers to the videos completed 6 months following the initial simulation exercise.*

Much work in simulation retention has emphasized complex motor skills, such as cricothyroidotomy[22] and manipulation.[12] Although results from this work are promising, disagreement exists as decay in learning also has been documented.[24,25] Debriefing has been considered critical in helping explain retention of skills for up to a year.[23] In this research, debriefing was provided as well as a second opportunity to recreate the simulation to emphasize learning. This research differs from previous work in that the scenario emphasized private office decision-making, with lesser technical skills, such as AED administration. Clearly, however, the data support learning retention of critical outcomes at least to the 6-month follow-up, even under those circumstances.

Unfortunately, despite an appreciation for the educational value of high fidelity manikin-based simulation programs, associated costs are extremely high, and cost-effectiveness is difficult to calculate.[25] As such, decisions must be made regarding the most efficient and effective manner in which to integrate simulation experiences into undergraduate health care education. For this educational setting, it has involved creating groups of students, some of whom would play a more minor role in a simulation and some of whom are intended to play a greater role. The greater role in the simulation experiences studied here were associated with the interns choosing the role of "doctor," while the more minor roles were filled to provide a realistic private office setting (including, for example, a receptionist). Concern was raised, however, that in the attempt to be efficient, effectiveness might be lost. Data from this investigation indicated that this has not been the case. In fact, regardless of the role played initially, learning achieved by those playing a critical role in the initial simulation event was retained equally well after 6 months compared to those who had played a lesser role.

Data from this investigation are intended to provide guidance for the continued cost-effective integration of manikin-based simulations. As with any study, however, limitations must be considered before generalizing the information provided. First, the sample size for this investigation was small. Although the researchers believe that the data are representative of typical simulation experiences, small data sets always are at risk of containing unique descriptors that can bias outcomes. Second, only 1 simulation scenario was considered. Previous work provided good evidence that the scoring method used was sufficiently robust to conduct this work.[13] However, more investigation is needed to determine if other scenarios will show the same retention patterns. It is noted that technical skills seem to be relatively easily maintained after simulation exposure; however, other interactive and decision-making factors may be more scenario-dependent.

**Table 2 - Mean Scores Dependent on Role History at the 6-Month Follow-Up**

| Doctor Experience | *n* | Mean (SD) |
|---|---|---|
| Original simulation and follow up | 12 | 15.3 (1.4) |
| Only at follow up | 11 | 15.2 (1.9) |

## CONCLUSION

High fidelity manikin-based simulation experiences are understood to include the high costs associated with the manikin, as well as the supports necessary for the educational system itself. As a result, groups of learners may play a greater or lesser role in some scenario exercises. In a simulated private office-based cardiac scenario, associated largely with decision-making rather than technical skills, evidence of learning retention was observed 6 months following their initial experience, regardless of previous role played.


## ACKNOWLEDGEMENTS

We would like to acknowledge Stefanie Triano and Anthony Giuliano for their assistance with data management.

## FUNDING AND CONFLICTS OF INTEREST

Neither author has any conflict of interest nor financial interest relative associated with this work. The research associated with this manuscript was internally funded by the academic institution of both authors.


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This article was received March 10, 2015; revised June 2, 2015 and June 18, 2015; and accepted June 19, 2015.


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Concept development: DG, MM. Design: DG, MM. Supervision: DG, MM. Data collection/processing: DG, MM.

Analysis/interpretation: DG, MM. Literature search: DG, MM. Writing: DG, MM. Critical review: DG, MM.



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